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INTERNATIONAL RICE COMMISSION

NEWS LETTER

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SUMMARY REPORT OF THE MEETINGS OF THE TWO WORKING PARTIES OF THE INTERNATIONAL RICE COMMISSION

THE Fourth Meeting of the Working Party on Rice Breeding and the Third Meeting of the Working Party on Fertilizers of the FAO International Rice Commission, were convened by the Director General of FAO and held concurrently on 21-27 September, 1953. The Meetings were held in Bangkok through the kind invitation of the Government of Thailand. They were attended by 56 participants representing 19 governments and 3 international organizations. During the period 3 excursion trips were arranged by the host government to see rice selection and hybridization projects and fertilizer experiments in Bangkhen, Rangsit and Chiengmai.

The following is a summary of recommendations and decisions of these two Working Parties:

Working Party on Rice Breeding

The International Rice Hybridization Project

The Working Party heard the satisfactory progress made on the international rice hybridization project now in progress at the Central Rice Research Institute, Cuttack, India, and expressed its appreciation of facilities provided for the project by the Government of India and its thanks to the Director of the Institute and his staff for their contribution to the progress of the project.

With regard to the handling of the hybrid material in participating

countries, the Working Party recommended that as large a population as possible of the F_2 should be grown and that, wherever the availability of facilities and personnel permit, the progeny selection technique should be adopted, carrying forward at least 100 - 200 progenies in each cross. The material should be grown in the normal crop season, and testing for sensitivity to photoperiod should be delayed until later generations when small portions of the progenies could be grown in the off-season. To bring out the responsiveness of selections to high fertility conditions, it was recommended that progenies should be grown under both normal and high fertility conditions at as early a stage as possible.

Since Expanded Technical Assistance Program funds are limited, further financial contributions to the hybridization project from participating governments would be welcomed.

The Cooperative Project on Interaction between Varieties and Transplanting

The Working Party was of the opinion that this project might be dropped as a cooperative undertaking, but recommended that countries should take up investigations on direct sowing of seed in lines and compare it with transplanting.

The Cooperative Project on Photoperiod Response

It was agreed that this investigation be repeated, but since some working difficulties were experienced, particularly in dissecting plants periodically to observe ear primordium formation, it was decided that such dissection be limited to 3 varieties in each of the sensitive and non-sensitive groups.

The Cooperative Project on Resistance to Lodging

The Working Party felt that to make the results of investigations on tensile strength and bending of the stem undertaken in different countries comparable, it was necessary to adopt a common method utilizing clearly defined uniform material. It was also considered necessary that to determine the extent to which characters under observation were actually related to lodging, selected varieties with lodging, intermediate and non-lodging straw should be grown in a replicated experiment and records on characters taken. The Working Party drew up suitable schedules to carry out the above program.

Breeding for Resistance to Piricularia and Helminthosporium

It was pointed out that existing information did not support the idea of physiological races of the two fungi although structural and growth differences have been observed, and that temperature conditions might affect the breakdown of resistance in resistant varieties in different regions. The Working Party recommended that investigations be conducted wherever possible on temperature in relation to host infection by these two fungi, as this information would be necessary for determining the existence of physiological races.

Seed Multiplication and Distribution Programs in Member Countries

It was agreed that satisfactory seed

multiplication and distribution programs were of great importance since the extent of area covered by improved varieties was a measure of the effectiveness of plant breeding services. It was pointed out that a successful seed project should include the actual demonstration of the superiority of improved varieties in farmers' fields and the provision of facilities for storing and distributing seed to farmers at the village level.

The International Training Centre on Rice Breeding.

The Working Party was unanimous in its opinion of the usefulness of such training as a means of strengthening the rice breeding services of member governments and recommended that a further similar training centre should be organized as soon as possible. To meet the financial difficulties which prevented the FAO to arrange for the training centre again, the Working Party recommended that FAO should explore the possibility of cooperating with other agencies, and that delegates urge their governments to assume the full cost of travel and subsistence for their nominees.

The Maintenance of Genetic Stocks of Rice.

The Working Party after considering the report submitted by the Special Committee constituted last year passed recommendations on the nature of material that should be registered in the World Catalogue and also agreed that the material should be maintained in duplicate at various suitable locations—the *indica* and *bulu* types at Cuttack (India) and Bogor (Indonesia), the floating rices of *indica* at Cuttack (India) and Habiganj (E. Pakistan), and the *japonica* types at Hiratsuka (Japan) and at a suitable place in the U.S.A. It also recommended that overall and continuing supervision of the arrangements for maintenance of stocks should be the responsibility of a technical officer of a member government of the Working Party on Rice Breeding who will receive reports annually from Directors of participating stations. It was hoped that the Director of the Central Rice Research Institute, Cuttack, India, would be able to act as supervisor.

The World List of Rice Breeders and the World List of Plant Breeders.

Copies were distributed to delegates inviting additions and corrections for inclusion in forthcoming revisions and supplements to these two publications. These publications were prepared by FAO as a service to plant breeders to facilitate the world-wide exchange of information and breeding material among them.

Working Party on Fertilizers

The Working Party, after reviewing the major aspects of its program of work and exchanging views and experiences on fertilizer problems, experimentation and practices, adopted the following recommendations:

1. That the Working Party on Fertilizers should assist in the task of summarising the basic physical data on the response of crops to different amounts

and kinds of fertilizer, the data to be complied in a form that may be readily utilized by Governments in developing policy on the production, importation, pricing and use of fertilizers.

2. That FAO should be requested to undertake the responsibility of preparing an appropriate questionnaire and the necessary data forms, with detailed instructions as to how to present the available data on response curves, so that a uniform approach can be made in each country.

3. That where it is necessary to amplify the existing data on response curves, scientists of the recpective countries should initiate experiments designed according to a plan to be drawn up by the Working Party.

4. That FAO should be requested to make available the services of a full time soil fertility specialist for liaison and correlation of experimental work on paddy in the countries of South East Asia. He should be stationed in the region.

5. That member countries should be urged to appoint a technical representative to serve preferably as a permanent liaison officer between the Fertilizer Working Party and the scientists of their respective countries.

6. That FAO should explore on behalf of the Working Party the possibility of making arrangements whereby a limited number of soils can be tested chemically and biologically, in order that paddy soils representative of the various rice producing countries and representative of a range of productivity and fertilizer response levels could be compared on a uniform basis.

7. That the Working Party on Fertilizers should assemble and discuss information relative to educational programs, credit and to other policies which are or might be used to promote the effective use of fertilizers on rice.

8. That in view of the success of the FAO International Training Centre on Soil Fertility held at Coimbatore 15 July-15 October, 1952, FAO should explore the possibility of arranging another such training centre as soon as convenient.

9. That FAO should explore the possibility of arranging for the compilation and publication of an annotated bibliography of nutritional, chemical and physical aspects of lowland rice soils.

10. That the Working Party in its discussions and reports should express fertilizer field results wherever possible in terms of increased weight of produce in

relation to weight of the nutrient applied (standardized to a uniform dose), since this is a term having maximum meaning for the evaluation of the results, and its use would avoid the awkward transformations now necessary with any one system of weight and area measurement. The Working Party further recommends that the metric system of measurement be used, in accordance with an earlier recommendation of the IRC.

Topics discussed at the Joint Sessions of the two Working Parties

The following topics were discussed at the joint sessions of the two Working Parties:

Physiological Diseases of Rice

The Working Parties recommended that investigations on physiological diseases of rice, like *mentek* in Java, *Penayakit merah* in Malaya, *browning* in Ceylon, and *pan-suk* in India and Pakistan, be undertaken on a cooperative basis. It also recommended that an officer of the Department of Agriculture in Malaya be made the coordinator for this project who will maintain contact with investigators in Ceylon, India, Indonesia and Pakistan and formulate a plan of investigation.

Experimental Designs for Variety Tests and Fertility Surveys

The Working Parties felt that experiments should be of two kinds, one complex with as many treatments as possible to be undertaken at experiment stations, and the other simple with as few treatments as possible to be undertaken in cultivators' fields. The Working Parties recognised that in many Asian countries the statistical services required to advise on experimental designs did not exist and suggested that FAO should advise on suitable designs for experiments and also help in the analysis of data for countries that needed the help.

Plant-Soil-Water Relationships

The Working Parties recommended that FAO should continue to collect and summarize information on the various phases of the subject of soil, water and plant relationship subject. In recognition of the fact that alternately flooding and draining is the common cultural environment of the rice crop in all rice growing areas, the Working Parties further recommended that Member Governments consider as a study of common interest the effects these flooding and draining alternations have on the physical, chemical and microbiological changes in the paddy soil.

The Cooperative Project on Interaction between Varieties and Fertilizers

The Working Parties recommended that the project be continued on the standard basis suggested in 1952 and, if possible, with a larger number of varieties. It was agreed that all relevant observations on such characters as lodging and incidence of diseases should be recorded.

PLANT-SOIL-WATER RELATIONSHIP

M.V. Vaachhani, Agronomist
Central Rice Research Institute, Cuttack, India

Rice cultivation is mostly concentrated in South-East Asia where a tropical humid climate is prevalent and the bulk of the crop depends for its water supply on the monsoons. The amount of soil moisture available for plant growth depends upon the amount of precipitation except in areas where irrigation is feasible. The total amount of rainfall received during the crop season, however, may not be wholly useful for the crop growth. The effectiveness of rainfall depends on its distribution during the crop season, topography of the land, soil texture and its moisture retentive capacity and the climatic factors which determine the amount of evaporation. Thus in spite of adequate rainfall, the crop may partially or completely fail due to erratic distribution, viz., the late arrival of rains, prolonged drought periods during the crop growth, or the early break-downs of monsoons before the crop matures. Besides, excessive rains during the crop season may cause floods and submergence of the crop. Thus the complete dependence of the rice crop on rainfall is hazardous and it is necessary to provide facilities for artificial irrigation for timely and expeditious planting and successful maturing of the crop.

Extent of irrigation in India

Agriculture in India depends upon the rainfall received mostly from the S.W. monsoon during the months of June-September. Out of the total annual cultivated area of about 250 million acres, about 47 million acres, or 19 percent of the area, have irrigation facilities. With the completion of several new multi-purpose projects it is estimated that an additional 30 million acres will receive canal irrigation water. At present, only about 20 percent of the 75 million acres under rice has some protective irrigation available. Rice yields in the rainfed areas are generally low but, wherever protective irrigation is available, the average yields are higher.

Water requirements of the rice crop

Before planning an irrigation system, it is necessary to have proper estimation of the water requirements at different growth stages of the crop. Though India has got the largest irrigation system in the world, comprehensive data on the water requirements of different crops are not available. In recent years more attention has been paid to water requirements in relation to soil conditions for certain commercial crops, like sugarcane, which is mostly grown under artificial irrigation and some very useful data have been collected. Unfortunately, very little information is available regarding the rice crop and whatever we have is empirical, more of a qualitative nature rather than quantitative and is not based on comprehensive research. The water

requirement of rice is larger than that of any other crop of similar duration, though it varies with soil, climate, cultivation practices and the variety grown. Efficient use of water rests fundamentally on the extent of information on the optimum relationship of the crop yield and water use. Therefore, it is necessary to conduct comprehensive research in various soil regions and climatic zones on a coordinated basis to obtain reliable data.

The term, "water requirement," as used in plant physiology means the ratio of weight of water transpired by a plant during its growth to the weight of dry matter prcduced and is known as the *tranßpiration ratio.* This ratio is different for different plants and varies with the conditions of growth. Besides transpiration loss, water is also lost from the soil surface by evaporation. Therefore the absolute water requirement or the *consumptive use* of water is defined as the quantity of water in acre inches per crop season absorbed by the crop, together with the evaporatien from the crop producing land. From the agricultural and irrigation point of view, the total water requirement of a crop will be equal to the consumptive use of water plus the percolative loss, the surface run off and the loss in distribution.

Water transpiration ratio for rice crop

Attempts have been made to determine the minimum water requirement of rice on the unit dry matter production basis. Experiments were conducted at the University of Banares and in Assam. The investigations were conducted under controlled conditions in pots and the standard methods adopted by Briggs and Shantz were followed. Ganguly[1] has reported that the transpiration ratio varies with different varieties and is influenced by various environmental factors. The data obtained by him are given below:

I. Effcet of soils on water requirements of rice

Nature of soil	*Average water transpired in grams.*	*Total dry matter in grams*	*Water requirement—Transpiration Ratio*
Clay	6,735.84	10.25	657.16
Loam	6,339.89	8.75	734.56

This water requirement is lower in heavy clay soils than in loamy soils.

II. Effect of length of maturation period on water requirements of rice

Variety of rice	*No. of days from transplanting to flowering*	*Av. water transpired in grms.*	*Total dry matter in grams.*	*Water requirement-Transpiration Ratio*
Tepi Dumai	46	6,921.66	15.53	445.58
Basmati/aus	65	12,673.87	24.76	511.74
Baurash Murali	76	18,610.47	34.93	532.52
Mow birain	109	25,346.32	47.32	537.78
Sail badal	118	26,045.12	44.09	590.78
Lati sail	123	24,585.13	40.08	613.40
			Average	538.6

Tbe transpiration ratio varies directly with the duration of the variety.

III. Effect of different fertilizers on water requirements

Treatments	*Av. water transpired in grms.*	*Dry matter in grms.*	*Water requirement-Transpiration Ratio*
1. No manure (control)	24,428	43.82	557.5
2. Cowdung	21,024	32.64	644.1
3. Ammonium Sulphate	32,471	50.89	638.1
4. Ammophos	30,994	42.61	727.4
5. Ammonium sulphate + super phosphate	38,596	61.3	629.6
6. Cowdung, super phosphate	33,449	59.41	563.0

The above data indicates that the water requirement is minimum in the "no manure" control plot and highest with ammophos application.

Singh, *et. al*[2] also determined the water requirements of varieties differing in length of maturation period and the data obtained by them are given below:

Variety	*No. of days from transplanting to harvesting days*	*Average water transpired per plant in grms.*	*Average dry weight per plant in grms.*	*Water requirement—Transpiration Ratio*
Kuari	85	1,825.8	4.62	395 ± 5
Jhengi	99	3,976.0	8.36	475 ± 13
Karahni	99	3,211.0	6.24	514 ± 6
Dehula	99	2,516.4	4.79	525 ± 4
Badli	106	4,116.0	8.78	468 ± 4
Saro	106	5,450.8	10.90	500 ± 3
Karangi	106	3,173.4	6.33	502 ± 7
Jilhore	120	4,731.4	7.50	630 ± 5
Kasturi	120	4,842.0	7.62	635 ± 5
			Average	519

Thus the water requirement of different duration varieties varies with their duration, and the average water repuirement is practically the same as obtained by Ganguly (*loc. cit.*).

Singh *et. al.* also investigated the critical periods of water requirements in the life cycle of the rice plant. This was calculated by dividing the weekly transpirational loss of water by the dry matter produced during that week. The following marked periods of high water requirement were observed in the life cycle of the rice plant:

1. The initial seedling period covering about ten days.

2. The pre-flowering and flowering period covering about 25 days.

3. Grain formation period covering about 5—7 days.

The water requirement of the rice plant is highest during these periods and if there is deficiency then the crop will be adversely affected.

Water requirements of rice based on field experiments

The water requirement under field conditions will vary according to the soil, climate, cultural practices and the variety grown, but efficient use of water can only be made if the optimum requirement of water for a particular condition is known. The irrigation department is primarily concerned with achieving the higher *duty* of a crop which is determined by the total area cultivated with one *cusec* of water i.e., continuous flow of cubic foot of water per second. The rice crop duty varies with different tracts depending upon the nature of the soil and the underground water table. In Madras State, it is estimated that the rice crop duty is fifty in Coimbatore, 70 in Tanjore and nearly a hundred in Godavari area. For the general purpose of irrigation, the average rice crop duty is estimated to be 80 and the total quantity of water at different growth stages of the rice plant is based on the following data:

Raising seed bed for 1 acre	—	1 acre inch
Transplanting of crop	—	22 acre inches
Maturing of crop	—	37 acre inches
Total quality of water	—	60 acre inches.

Effectiveness of rainfall

Since rainfall is the major source of water supply for rice in the region, it is necessary to estimate the proportion of the rainfall which would be beneficial to the crop. In the case of very light showers the water may not reach the root zone and may be lost by evaporation. Similarly, in the case of heavy downpours the major portion may be lost by the surface run off, or by percolation in the deeper soil layer beyond the zone of root action. Therefore, the rainfall is usually divided into 'effective' and 'non-effective.' The effectiveness of the precipitation in promoting plant growth depends on how much of it reaches the soil in the root zone of the crop and contributes towards raising the soil moisture and becomes available to the plant.

For calculating the effective rainfall the irrigation department usually adopts the following broad principles, which are based on soil moisture studies:

I. Transplanting period of rice crop (June - August)

1. Rainfall less than $\frac{1}{4}''$ on any one day is considered ineffective.
2. Excess rainfall above $3''$ on any day is considered ineffective.
3. Total rainfall more than $5''$ in 10 day period is considered ineffective.

II. Rice maturing period (September-November)

1. Rainfall less than $1''$ on any one one day is considered ineffective.

2. Excess rainfall above $2''$ on any day is considered ineffective.
3. Total rainfall more than $3''$ in 10 days period is considered ineffective.

This division of rainfall into 'effective' and 'non-effective' is only a rough estimate for practical purposes.

Future lines of research on water requirements of the rice crop

The irrigation problems confronting rice research workers are chiefly: (a) the determination of the optimum requirement of water; (b) its distribution for getting the most economic returns; and (c) the interaction between the optimum yield and other factors like irrigation, climatic factors, soil type, manure and cultural operations.

From the point of view of utilization of canal irrigation water, the following problems need to be investigated with regard to the conditions prevailing in the area: (a) the effectiveness of natural precipitation for normal crop growth; (b) the quantity of additional irrigation water required at different periods of plant growth, and (c) the *duty* of cropping.

As the water, soil, climate and the crop are the important factors for securing reliable data on the plant-soil-moisture relationship, it naturally follows that coordinated and comprehensive research must be carried out jointly by irrigation engineers, agronomists and soil physicists and that agronomic experiments should be conducted in different soil and climatic regions according to standard designs so that the data obtained may be comparable. The aims of these experiments should be to collect information on (a) the total quantity of water required by the rice crop; (b) frequency and intensity of irrigation; (c) loss due to percolation, evaporation, lateral movement and surface run off; and (d) the effect of different fertilizers and cultural practices on the water requirements of rice. The appropriate experimental technique for such coordinated investigations should be first worked out.

References:

1. Ganguly, P.M. (1950) – Rice in Assam, *Bull. No. 6 Paddy Series*, Assam, India.
2. Singh, B.N., et. al. (1935). Investigation into the water requirements of crop plants, *Proc. Ind. Acad. Sci.* I: 471-495.

THE CONTRIBUTION OF SHORT COURSES TO THE RICE IMPROVEMENT PROGRAM OF THAILAND

Krui Punyasingh, Department of Agriculture, and
H.H. Love, Special Technical and Economic Mission to Thailand

When the enlarged rice improvement program for Thailand was being considered it was at once apparent that there would be needed a large number of men trained in the methods used for handling field plot tests, as well as in some of the basic principles of plant breeding, statistics and other subjects. Men with this training were not available and there was not time to send them abroad for special training; nor were funds at hand for this purpose. Something had to be done quickly to provide the needed staff with some knowledge of the kind of experiments that were to be conducted. Specially planned Short Courses seemed to provide the only answer to the problem. Naturally some people wondered whether it would be possible to accomplish anything worthwhile in the short space of four or five weeks. Also some questioned the value of such courses if the lectures had to be interpreted from English into Thai. Personal experience of one of the authors, gained from having conducted short courses for several years in China, had shown that much could be accomplished by such short courses lasting from four to six weeks even when most of the lectures had to be interpreted from English into Chinese. Naturally it would be better if all teaching could be done in the native language, yet, when this cannot be done, it is possible to handle the instruction providing satisfactory interpreters are available. Fortunately this has been the case for the short courses conducted in Thailand.

The first short course was held in October 1950 and the average attendance was about 87. It has not seemed desirable to set up any special requirements for admission. Those attending included a few staff members of the Thai Department of Agriculture, the University of Agriculture, a few students from the University, and a large number of agricultural officers employed by the Department of Agriculture and stationed in different localities of the Kingdom. Most of the agents had not had the benefit of college training nor the opportunity for special technical instruction in agriculture.

The instruction for the first course included lectures on the nature of soils, and the importance of fertilizers. Some of the basic principles of genetics, including cell development and growth and their relation to genetic reactions were presented. The methods of selection and hybridization and their application to plant improvement were discussed. The value and limitation of selection were illustrated with data from different types of crops, and how selection may be used in rice improvement was discussed in detail. How hybridization may be

applied in producing new types of plants to meet certain needs was explained. The use of statistics as applied to the analysis and interpretation of the results of field experiments was exemplified by numberous examples. The kinds of experiments that may be used for field plot tests including such points as size and shape of plots and number of replications needed were discussed. Naturally in the short time that was available it was only possible to present some of the most important phases of the several subjects, yet, as will be seen later, much was accomplished. Those who attended the course seemed anxious to become familiar with the various techniques presented, and to learn how they might help in the development of the rice improvement project.

Such short courses need to be repeated at least once a year. In this way it is possible to reach additional men, and former members may return for further training so that they may increase their knowledge and clear up some points that may not have been well understood the first time. Those who have attended previous courses should be urged to return for more training and their duties should be adjusted so that it will be possible for them to attend.

A second course was held from February 4 to March 15, 1952, and a third one from January 19 to February 25, 1953. The attendance at the second one was about 90 while the average attendance for the third one was about 94. A number of men who had attended the previous courses, returned for further training. For each of these courses new material was presented, and some special lectures on different phases of agriculture were given by specialists working in those fields. For part of the time the class was divided so that some advanced work could be presented to those who had attended previously. Special laboratory sections were also held for the more experienced members so that they could carry through some of the statistical procedures required in the analysis of data from field experiments. A number of the members brought with them data from experiments they had helped conduct. These men used their own data in the laboratory work. The steps in the analysis of the data helped them to a fuller understanding of the purpose and meaning of field tests.

Experience has demonstrated that it is better to hold short courses on specific subjects such as rice improvement rather than to hold one on broader lines like one on general agriculture. Since it is usually not possible to continue such courses for more than four to six weeks at a time, it is not feasible to include lectures on a wide range of subjects.

The value of such special training courses may be illustrated by indicating what several of the agricultural agents who attended the first course in 1950 were able to do in connection with the experimental work of 1951. Before it was time to plant rice that year a number of those who had attended the first course were contacted to see if they were willing to help conduct field experiments for

variety comparisons and for comparing the effect of different fertilizers. Many agreed to take part in this work. They were asked to come to Bangkok for further training and to receive special instructions on the laying out and arrangement of field plots. They were also instructed on the care needed in handling experiments of the kind being planned. The importance of transplanting all plots in as nearly the same way as possible was stressed, including such points as the same number of hills in each plot and the same number of plants in each hill. These men then returned to their home localities to arrange for the land needed for the test plots, and to plan for the seed beds and other details.

Most of those who agreed to share in the program did satisfactory work. This is remarkable when one considers the fact that none of them had done anything of this sort before. It was to be expected that a few mistakes would be made, but on the whole the experiments were well handled. In order to enable these men to see rice growing in different parts of Thailand, and to give them the opportunity of further training by observing the tests conducted by other agents they were asked to return fo Bangkok late in September. For a few days they were given further special instruction, and then were taken on a tour, under direction, to see a number of experiments in central and northern Thailand. This proved to be most beneficial. The men agreed they had learned a great deal from what they had seen. As they visited an experiment that was well laid out, cleanly cultivated, and with a uniform stand they could easily compare this with another one that may not have been so well handled. This kind of follow-up study adds considerable to the value of the short courses. Such observation tours should be an integral part of the short course programs, and should be taken every other year if it is not possible to do so each year. Unfortunately, on account of the expense involved and the lack of accomodations not all those, who need to profit by such inspection tours, can always be taken. Such trips enable the men to relate the material presented in the lectures to the practical problems concerned with well handled field experiments. It has the added advantage of encouraging each one to make certain that his test plots will be among the best another year unless circumstances beyond his control makes this impossible.

It was recognized in the very beginning of the enlarged program that the extent of the experimental work would be limited primarily by the number of available men with the type of training necessary for the proper conduct of worth-while field tests for comparing the yielding ability of strains and varieties of rice, and measuring the effect of different fertilizers. The short courses have contributed much to help meet this need.

As a result of the training presented in the first course in 1950, it was possible to expand our program from only a few experiments to a larger number in 1951. In 1950 we had some variety tests at the main stations, but in 1951 we were able to plan, in addition to the

tests at the main stations, for 12 regional tests. Regional tests are placed on farmers' fields in different areas of the Kingdom, and are used to compare the yields of about 20 varieties. Some of these varieties are sent from our stations to the different localities, and several of the better local sorts are added to the test. In addition to the variety tests about 19 fertilizer tests on rice were also conducted in 1951.

For 1952, due to the fact that more trained men were available, it was possible to have 29 regional variety tests. The number of fertilizer tests was also increased to 29.

For 1953 plans have been made for 57 regional variety tests and for 88 fertilizer experiments.

This expansion would not have been possible if it were not for the willing cooperation of the many members of the short courses who volunteered to assist in these experiments. In no other way could the program have been expanded so rapidly.

Thus experience is showing that many of the men, who have attended the short courses, are proving to be most valuable in this expanding rice improvement program. In time some of them will have advanced to the point where they can conduct certain experiments independently. Since sufficient trained personnel is likely to be unavailable in numberous situations for some time, then the only alternative is to continue to train them by means of special short courses organized for the purpose.

Some of these men are becoming so proficient that they may now serve as regional supervisors helping those less experienced look after certain experiments in a particular locality, or several localities. The results so far have been very gratifying.

JAPANESE METHOD OF RICE CULTIVATION IN INDIA*

K. Ramiah

Rice Expert, Agriculture Division, FAO Regional Office, Bangkok

Main Features of Japanese Method

The main principles of rice cultivation as followed in Japan, which produces the highest acre yields in Asia, are well known to the technical officers of the departments of agriculture in India but no active steps had hitherto been taken to highlight them among rice growers as a special campaign beyond what was being done in regular extension work. What is actually the Japanese method of rice cultivation? The most important features associated with it are: (i) selection of good and heavy seed for sowing in the seedbed, (ii) sowing the nursery as thin as possible, (iii) having

*Report prepared after his visit to the country in April 1953

raised seedbeds a few inches above the level of the field, (iv) manuring the seedbed adequately with both organics and inorganics, (v) removing the seedlings when ready with the least amount of damage to the roots and transplanting them in lines with adequate spacing, (vi) heavily manuring the transplanted fields with organics and inorganics, and (vii) frequent inter-culturing or stirring up of the soil in between the rows, 4 to 5 times when the crop is growing. The State Governments have been consulted and thousands of charts and leaflets suitably illustrated have been prepared for distribution to rice farmers throughout the country. These leaflets written in all local languages describe the methods suitably modified according to the conditions obtaining in the different states. Arrangements have also been made to train workers, officials and non-officials, who will be in charge of the extension work connected with this campaign,

Relative Importance of the Several Features

Although all the points (i) to (vii) mentioned earlier together constitute the Japanese method there are no experimental data to determine the relative importance of the different factors contributing to increased yields. The Indian Council of Agricultural Research has suggested to all the state departments that they should carry out a suitable experiment in their research station to obtain reliable information on the above point. But the figures of a simple experiment already carried out in Bombay State dealing only with some of the factors show clearly that the factor having the largest effect on yield was the fertilizing of the transplanted field. The contribution due to manuring of seedbed was very much less, hardly one third of the contribution by field manuring and the contribution due to inter-culturing was still less, about a third of the increase due to seedbed manuring. Even the small benefit accruing from the manuring of seedbed may be special to Bombay and not applicable to conditions in other states. This is from a rough preliminary experiment and more reliable information is bound to come from the better planned experiments that are being undertaken now in all states. There is however no doubt that fertilizing of the field is bound to be the most important contributing factor, and in advocating the Japanese method greatest emphasis has to be placed on this. There are sufficient experimental data available already in different states with regard to the optimum quantities of manures or fertilizers to be used for rice grown in them. So long as the dose recommended is kept within the maximum dose determined by experiments, we should be safe.

Seedbed. It has been mentioned already that the several features advocated with the Japanese method of rice cultivation are not all new. For example, sowing the seedbed as thin as possible to get strong and sturdy seedlings for transplanting is a recognized improvement and has been advocated as an item of propaganda in Madras State for over 30 years. In important rice areas of

that state this improved practice is already being followed. With regard to the question of raised seedbeds it is easy to adopt it when a dry nursery is raised. With regard to the wet nursery, the emphasis should be on long and narrow beds so that levelling can be made perfect, resulting in satisfactory germination. With long and narrow beds with channels separating them, one cannot but have a slightly raised seedbed.

Selection of heavy seed for sowing by soaking the seed in salt water has been experimented with in different states. In genetically pure varieties developed from a pure line such selection is of value only in the case of early maturing rices, say 110 days and less, and not in varieties which take 160 days and more to mature. In the latter case it should be quite enough to eliminate light and half filled grains which float when the seed is soaked even in ordinary water. There may not be necessity to use salt water in this case. The main advantage in selecting heavier seed is that such heavy seed germinates quicker and the seedlings would be uniform in size at the time of planting. Manuring of the seedbed is however important and emphasis should be more on the organics rather than the inorganics, so that with a thick layer of organic manure on the top, pulling of seedings will be easier and with least damage to roots. Under Indian conditions too heavy manuring of the seedbed may be even harmful, particularly when transplanting cannot be done at the stipulated time due to inefficient water control.

Spacing between Plants. In Japan the spacing to be adopted between lines and the number of seedlings to be planted per hole have been determined by regular experiments. The research results help them to determine the total number of plants to be planted per unit area, the number of plants to be planted per hole being adjusted to the minimum spacing to be allowed between lines to facilitate inter-culturing. Population density per unit area is an important factor determining yield in cereals. In India also there are data to determine the spacing to be adopted in transplanted fields, but this varies according to the varieties grown. While most Japanese varieties of rice take 135-150 days to reach maturity, there are in India much earlier and very much later varieties to grow. For any inter-culturing to be done without damage to plants, 9-10 inches spacing between lines will be the minimum distance. Adopting this spacing for both early and late varieties should mean a larger number of seedlings per hole for early maturing varieties and fewer plants per hole for late maturing varieties. Of the two factors involved, namely, spacing between lines and number of plants per hole, the former is more important and necessary adjustments will have to be made according to the maturity period of the variety. With 10" spacing between lines 3 to 5 seedlings per hole for the early maturing varieties, 120 days or less, and 1-3 seedlings per hole for late maturing varieties may be the optimum requirements.

Inter-culturing. Planting in lines

and frequent inter-culturing are very special features of the Japanese method. Here emphasis has to be on inter-culturing, and planting in lines facilitates the operation. Inter-cultivation as practised in Japan does not consist merely in removal of weeds, but in stirring the soil between plants to a few inches depth. In well prepared wet rice, weeds are not a problem and a certain amount of weedling is usually done in India. Moreover this stirring of the soil adopted in Japan goes with intensive manuring, and perhaps such stirring helps the plant to assimilate better the added nutrients. Stirring of the soil without adequate manuring may not do much good, and in fact, the results of the preliminary experiment conducted in Bombay confirms this view. With regard to the number of inter-culturings, it will depend upon the variety grown. It may not be possible nor necessary to do it more than twice for an early variety and may go up to five times for a late variety. The last inter-culturing should be before the primordia is formed, i.e. about two weeks before short blade stage.

Manuring of the Field. While considering this, questions arise as to the quantity of the manure to be applied and the form in which it is to be applied. In Japan, the very large quantities of manures applied to rice is partly in the organic and partly in the inorganic form, the latter containing all the nutrients, N, P and K. Because of the varying soil and climatic conditions obtaining in different parts of India, it is not possible nor advisable to follow a standardised schedule. Moreover, information is available, though on a limited scale, mainly from experimental stations, (Bihar State is an exception), on the optimum and maximum doses of fertilizers to be used. In Japan all organic wastes are scrupulously collected and made into compost and this forms the main source of organic constituent. In India, the only organic manure available is cattle manure, but the quantity is limited. Fortunately, growing a green manure crop and turning it in is a practice that is slowly, but surely extending, and all available information points out that this is the best and the cheapest form of fertilizing rice fields. Available information does point out that where 3 to 4 tons of green matter can be turned in, there is no necessity to supplement it with inorganics. There are, however, facilities needed to make the practice of green manuring a more general one, and in any case it cannot be practised universally. The only means of fertilizing rice fields is to apply the available small quantities of organics in the way of cattle dung, compost and green manure and supplement them with chemical fertilizers. Each state has drawn up its schedule for fertilizing rice fields which contain both organic and inorganics. The inorganic source for nitrogen is universally ammonium sulphate and superphosphate in the case of phosphorus. Some states like Bombay and W. Bengal are recommending special mixtures where oil cakes and bone meal are added to the inorganics to replace part of the nitrogen and phosphorus requirements.

Nitrogen—Chief Requirement. Nitrogen is the most important requirement of Indian soils and it has been found that 20 lb. of N per acre is the minimum dose that can give a satisfactory response in most places. The optimum dose however varies from 20 to 60 lb. and it is even beyond 60 lb. in a few areas like parts of Bombay. So long as the total nitrogen requirement cannot be met by green manure, the use of ammonium sulphate for rice has to become an established practice. It is not necessary at this stage to go into the question of the possible bad effects on the soil of a continuous application of ammonium sulphate. Acid soils where its application is likely to be harmful are limited in extent. For most rice soils of India and with the limited quantities recommended supplemented by organics and phosphorus there is no necessity to be unduly apprehensive of such a bad effect. Research is going on and more fertilizer experiments under cultivators' conditions are being undertaken, and even where a harmful effect is likely to result from the use of ammonium sulphate other forms of nitrogeneous fertilizers can be considered. The use of more manure or fertilizer is the most imporant factor connected with the Japanese method, and in India it should mean a greater use of ammonium sulphate for the present, and possibly a change over to other forms of nitrogeneous ferlizers in the future where such a change is found necesssry.

Method of Applying Fertilizer. With regard to the method of applying the fertilizers the Japanese method consists in applying all the phosphorus and potash and a portion of the nitrogen just before planting, and the balance of nitrogen either in a single dose soon after planting or in split doses, one after planting and another much later, a few weeks before heading. Where the land is ploughed dry and then puddled and levelled which is the practice in Japan the initial application of the fertilizer is done in the dry condition of the soil. The interval of time between this application and puddling for transplanting is never more than a few days, within a week. This might be followed in India too where dry ploughing of the soil is practised. In areas where preparation of the land begins after letting in water the initial application of the fertilizer has to be at the time of planting with a minimum amount of water in the field. With regard to single or split doses it may be useful to follow the information available from experiments. Here again in the case of an early maturing variety it may be safer to apply it in one dose soon after transplanting. Split doses may be considered only in the case of late maturing varieties, and even here according to existing information it has not been found useful to postpone the last application six weeks beyond transplanting. Moreover, split doses may not be feasible where efficient water control does not exist.

The popularization of the so-called Japanese method should result in greater use of fertilizers in the country and this happens to be the easiest way of stepping

up acre yields. It has to be understood that the Japanese method could be introduced only in areas where raising of the seedbed, and transplanting the crop, are regularly practised and where reasonable water facilities exist. Rice is also grown as a purely rainfed upland crop in Japan. Here the crop is sown in lines, nearly a foot apart, and the space between is frequently inter-cultured and the soil earthed up on either side. Manures and fertilizers are applied at the base of the plant before earthing up. This practice is capable of being followed in parts of India where rice is generally broadcast just before the break of the southwest monsoon. Recently even for transplanted rice Japan has been experimenting with sowing the seed directly in lines and the results are said to be extremely satisfactory. The yields have been found to be as good as or even better than from a transplanted crop, and the additional advantages are the saving in labour and water use. There is no doubt there is scope for undertaking such experiments in parts of India.

Improved Varieties and Japanese Method

In the Japanese method, fertilizing the field and growing of an improved variety of rice are inter-dependent. According to them, improved varieties do well only when intensively fertilized, and the best returns are obtainable for the use of fertilizers only when improved varieties are grown. Suitable improved varieties are available to meet the requirements of different rice areas of Japan and the determination of varietal response to fertilizers is an integral part of breeding research. This question has perhaps not received much attention in India. Maximum yield of grain under ordinary methods of rice cultivation as generally followed has been the main objective in breeding. It has been found, however, in most places that the improved varieties have done very well with intensive manuring. In Japan there is a good organization to multiply and spread improved varieties, and in fact, Japan is the only country in Asia which has the largest percentage of rice area, about 70 parcent, covered by improved varieties. In India, the intensity of breeding and evolution of suitable varieties for different areas varies among different states, and it may be said that states like Madras, Bombay and Madyapradesh, do have a range of varieties to suit most of the requirements. The total area under improved varieties is not, however, impressive although according to information available with technical officers, the area as given in official statistics is a gross underestimate. The area given in statistics has been calculated mainly on the basis of the quantity of seed handled and distributed by the department whereas, there is an appreciable amount of spread taking place among cultivators themselves. Moreover there has been no satisfactory attempt made to determine the area under improved varieties which under conditions obtaining in India, a rice deficit country, is beset with special difficulties. Perhaps collecting information on varieties along with random

sampling for estimating yield could give a more reliable picture about the spread of improved varieties.

There should not be any difficulty in following the Japanese method in states which have already a range of improved varieties suited to different needs but in others where either suitable varieties for different areas are not available or the suitability of the existing varieties to such areas has not been determined the matter needs immediate attention. There is no doubt that the successful spread of the Japanese method should stimulate more intensive work in breeding to obtain varieties that will stand up to intensive manuring.

Implements Connected with Japanese Method.

Fortunately, the taking up of the Japanese method does not involve any outlay on special implements. Planting the seedlings in lines can be done by stretching a marked string across the field from bund to bund and shifting it after planting each line. This should be an easy operation where fields are small, about half an acre or less. It may be a problem in areas where the fields are large as in the flat river deltas. In Japan and Formosa where rice is always planted in lines, there is a special implement, a revolving drum made of cheap and light wood or even split bamboos which can be dragged along the field after it is properly levelled and where water has been drained off, and it leaves marks in the soft mud in a chessboard fashion and seedlings are planted in points where two lines intersect. Attempts are being made to design such an implement also in India. With regard to inter-culturing or stirring of the soil in Japan, there are special rotary weeders in use. Often a few of these of different sizes form an essential equipment with every rice farmer. The rotary weeders have been imported and tested in India, and they appear to be satisfactory. They are however somewhat expensive. One of the agricultural machinery manufacturing firms in Calcutta has turned out a weeder which is quite as efficient as the Japanese one. It costs Rs. 20/- each, and there is already a small demand that has developed. In Bombay and Madras the departments have designed special hand hoes with curved teeth which somewhat answer the purpose, although they cannot be as efficient as the Japanese weeder. They, however, cost only a rupee or less each.

Economics of Japanese Method

The Japanese method of rice cultivation does involve an appreciable amout of hard labour and attention to details, much more than the amount to which the general Indian rice farmer is accustomed. A question is often asked whether the Japanese method of rice cultivation is economical and whether the economics of the method have been determined for Indian conditions. In Japan as in parts of India the size of the holding is extremely small and the rice farmer has to put in unremitting and incessant labour to get the maximum possible out of the land so that he can make a decent living out of it. All members of the family including children

work in the field and the question of economics, i. e. calculating in money value every bit of work which the farmer or members of the family put into the field, does not arise. In fact, in Japan there is very little outside labour actually hired for the field work. Where necessary the farmers help each other in operations like transplanting or harvesting. In India also the taking up of Japanese method must involve more work on the part of the rice farmer. It will not, however, be justifiable to calculate the money value of every bit of field work as if he engages labour for every field operation and pays for it. If this is done, it may perhaps not prove highly economical. In Bombay the special leaflet does show the economics of the Japanese method and it appears to be highly profitable. There will, of course, be more labour involved in the preparation of seedbeds, weeding of the seedbeds, in transplanting seedlings in lines and in frequent inter-cultivation later. How far the farmer himself can contribute to this additional work or will be obliged to hire labour will depend upon circumstances of the individual, but in any case it has to be understood that the Japanese method is essentially a method suitable for small holdings and where the farmer himself is expected to contribute most of the labour involved. It follows also that there must exist sufficient facilities or incentives offered to encourage the farmer to put in more work in the field.

Facilities and Incentives.

While so far the technical aspects of the Japanese method have been discussed, there are certain physical facilities which the rice farmer in Japan has and which the Indian rice farmer has to be given to make the campaign an unqualified success. Principally these facilities are (1) making the fertilizers available to him as near to his door as possible and (2) providing credit facilities for him to purchase his fertilizer requirements. The former is perhaps not receiving as much attention as it should. The main requirement is the opening of of a larger number of depots in the interior of the country so that at no place the farmer has to travel more than 5 miles to get his requirements. Taking Madras State, the largest user of the fertilizer in India, in two districts, East and West Godavari where people have been using fertilizers, there is only one depot available at each taluq headquarters, about 13 in all for the two districts. While farmers accustomed to use the fertilizer continue to do it, the practice has not spread to neighbouring areas where practically identical conditions obtain. Opening of more depots and arranging for demonstrations in new areas could easily double the consumption of the fertilizers. Expenditure on these items should cost only a fraction of the cost involved in the whole campaign, and it should be quite worth undertaking. While it may not be ~~im~~possible to develop extension service in India to the scale available in Japan, at least a small strengthening of the service would be necessary if the campaign should prove an unqualified success.

How soon the working of the community projects and training non-official personnel will effectively help extension work remains to be seen.

The departments of agriculture are fully alive to the problem of increasing the number of depots where seed and fertilizers can be made available to rice farmers but the main difficulty appears to be finance. Any extension of the existing facilities could have the maximum effect in Madras State where the farmers are already fertilizer minded, much more than in other states. With regard to credit facilities all state governments have arranged to grant loans to rice farmers to buy their fertilizer requirements, the loan being given as fertilizers.

For the present, supplying of fertilizer at reasonable cost and making it easily available on credit could be sufficient incentives. There is, of course, the price of the produce which is, however, controlled though there may be variations in this from state to state. With an average price of Rs. 10/- a maund (82 lb.) of paddy and Rs. 400/- for a ton of ammonium sulphate, application of 100 lb. of ammonium sulphate costing Rs. 17 can be expected to bring an additional yield of 3-3½ mds. of paddy which means a profit of Rs. 13 to 18 per acre. With a lower price for or paddy a higher price for the fertilizer the profit will of course be less. Until recently, ammonium sulphate was being sold at Rs. 350/- a ton, and including transport and incidental charges was costing actually about Rs. 400/- to the cultivators in most places. In Madras the fertilizer was actually costing more than Rs. 450/- to the farmers. To encourage the use of the fertilizer and to give an incentive to the Japanese method, the Central Government which controls the production, import and distribution of the fertilizers has now reduced the price to Rs. 290/- a ton, which is a great incentive. This means that the farmer will not have to pay more than about Rs. 350/- at the maximum per ton at his door. Whether further incentives will be required can perhaps be decided as the program progresses.

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